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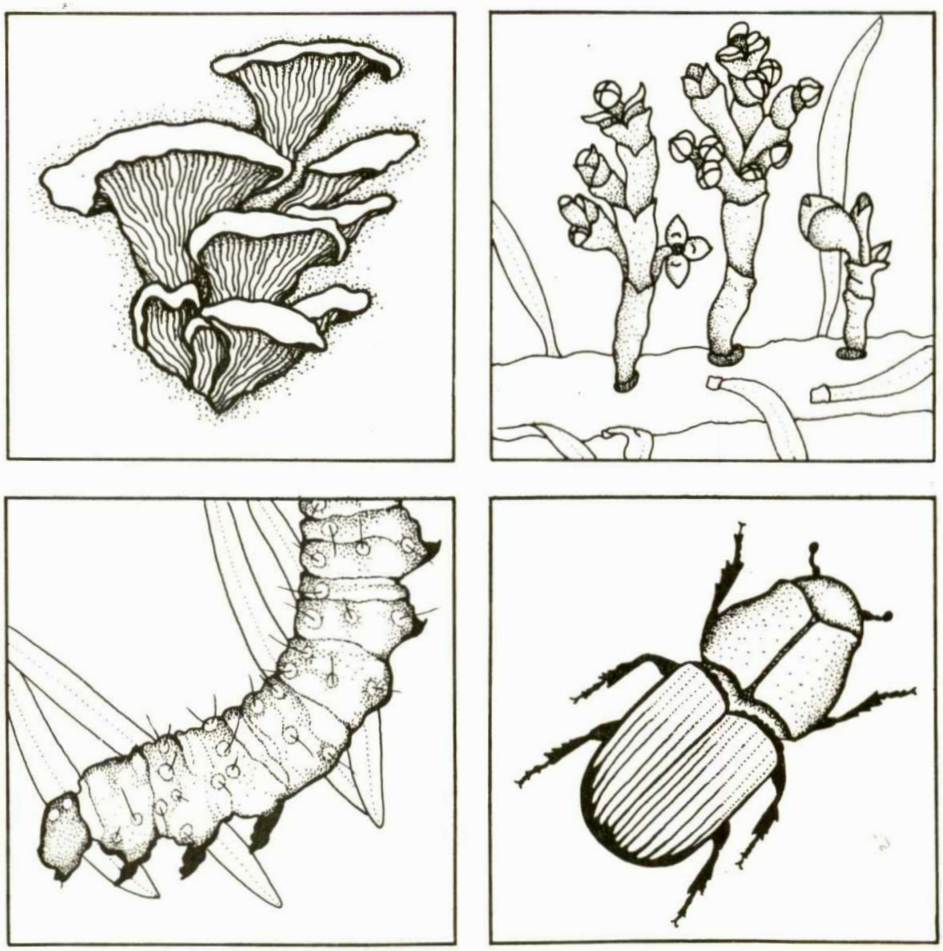
EVALUATION OF THINNING EFFECTS ON ROOT DISEASE MORTALITY OF YOUNG CONIFER REGENERATION ON THE RED RIVER RANGER DISTRICT NEZPERCE NATIONAL FOREST, IDAHO

Establishment Report



EVALUATION OF THINNING EFFECTS ON ROOT DISEASE MORTALITY OF YOUNG CONIFER REGENERATION ON THE RED RIVER RANGER DISTRICT, NEZPERCE NATIONAL FOREST, IDAHO ESTABLISHMENT REPORT

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ABSTRACT

Ten permanent plots were established within an 11-year-old plantation on the Red River Ranger District (Nezperce National Forest). Plots were located around groups of recent regeneration mortality caused by root disease. Five of the plots were thinned to an approximate 12- by 12-foot spacing; the other plots were left at original stocking levels. About 12 percent of the plot trees have either been killed by root disease or are currently infected. Groups of dying trees usually occur around infected stumps from the previous stand; Armillaria mellea is the major pathogen involved. Plots will be monitored to make comparisons of mortality rates between thinned and nonthinned regeneration.

INTRODUCTION

Root diseases cause serious long-term impacts in coniferous forest stands in the Northern Region. Losses are extensive on several northern Idaho and western Montana National Forests. Estimates for the Nezperce National Forest indicate that at least 3,800 ha (9,400 acres) of commercial forest land are occupied by large root disease centers detectable from large scale aerial photographs (James and Stewart 1981). This accounts for about 1 percent of the commercial forest acreage. Actual area infected is estimated at more than 7,600 ha (19,000 acres); this estimate accounts for infected trees near disease centers that lack above-ground symptoms (Wallis and Bloomberg 1981). Recent estimates also indicate that about 126,000 ha (311,000 acres) of commercial forest land have scattered root disease mortality [1/] (Stewart and James 1982). Therefore, we estimate that approximately 35 percent of the commercial forest land of the Nezperce National Forest is infected with root disease. Annual root disease mortality for the Forest is estimated at about 800,000 trees (5.4 trees/yr) which accounts for more than 10 MM ft^3 (68.7 ft^3/yr) (Stewart and James 1982).

Root-diseased stands with significant losses during the current rotation may suffer even greater losses during subsequent rotations because of buildup and persistence of pathogens within infested stumps (Roth, et al. 1980; Shaw and Roth 1976). Managed stands requiring several stand entries may suffer extensive root disease losses (Hodges 1969; Shaw, et al. 1976). Stumps serve as food bases for pathogens which can then spread through root systems or soil and successfully infect surrounding trees (Filip 1977; Huntley, et al. 1961; Roth et al. 1980). Unfortunately, inoculum often remains viable in stumps for several decades, resulting in a hazard to new crops of trees (James and Gillman 1980; Johnson 1976).

Root disease losses in young regeneration may not necessarily be detrimental if adequate stocking levels are maintained. Since more trees may

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1/ Defined as having at least one root-diseased tree per acre.

regenerate a site than are desired for crop trees, root diseases may "thin" some of the less vigorous individuals (Johnson and Hawksworth 1977). Unfortunately, root disease mortality is often not uniformly distributed in young stands, but rather occurs in groups resulting in portions of the stand being understocked (Filip 1979).

Precommercial thinning of young root-diseased stands might increase the infection hazard to selected crop trees by providing buildup of pathogens in stumps, or it might improve vigor of crop trees sufficiently to resist infection by root pathogens. Therefore, we plan to test effects of thinning on young root-diseased regeneration on the Red River Ranger District, Nezperce National Forest. The major goal of the evaluation will be to compare rates of residual tree mortality within thinned and unthinned plots and to determine eventual effects on stocking levels.

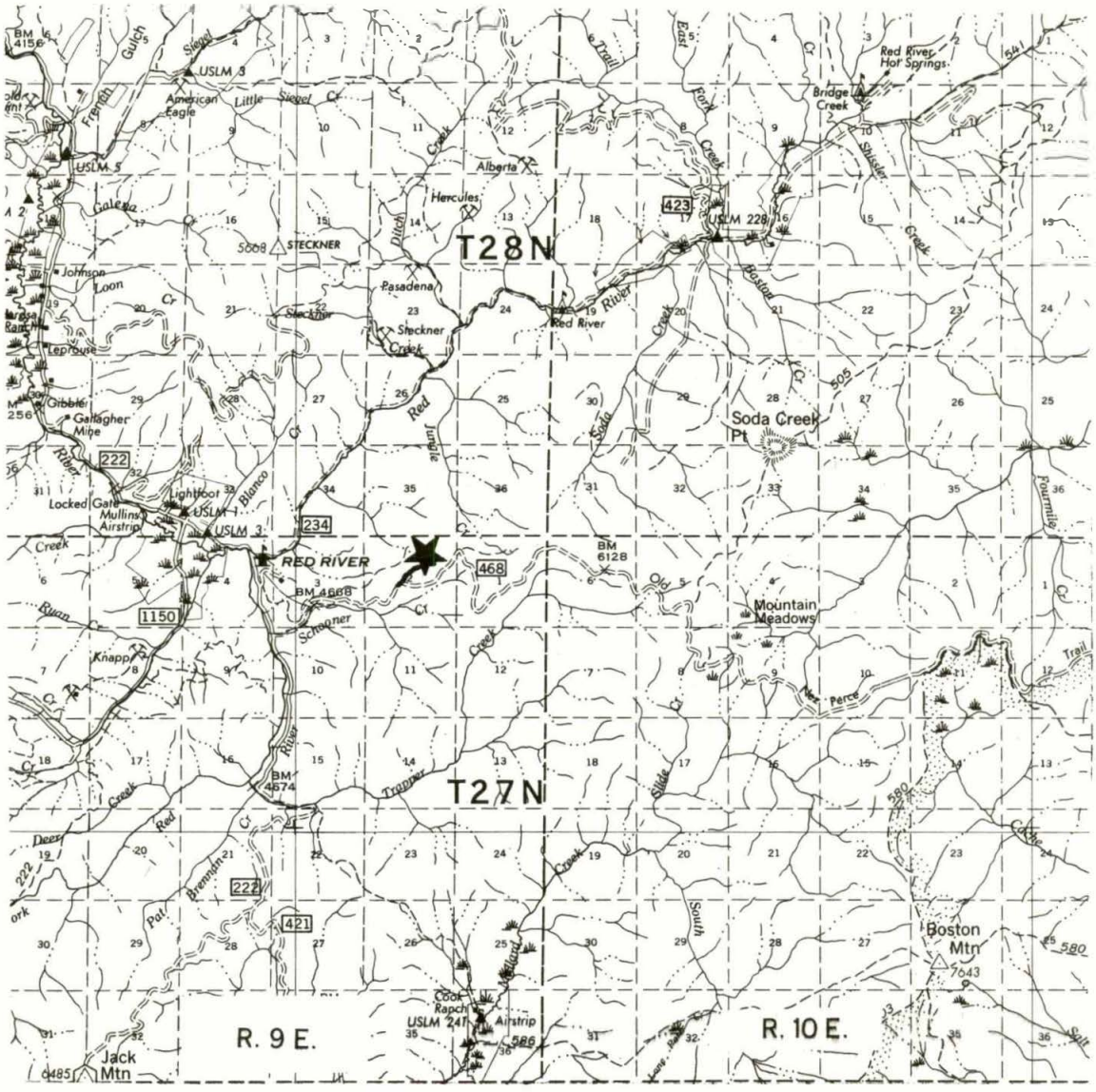
METHODS

The plantation to be evaluated (Soda Creek Unit #2) is located approximately 4 km (2.5 miles) east of the Red River Ranger Station in section 2, T27N, R9E (fig. 1), and encompasses about 10 ha (25 acres) at an elevation of about 1,500 m (4,900 feet). The plantation was established during 1970 following a 1968 clearcut; ponderosa pine (Pinus ponderosa Laws.) and Douglas-fir (Pseudotsuga menziesii Franco) were planted to supplement natural regeneration of grand fir (Abies grandis (Dougl.) Lindl.), lodgepole pine (Pinus contorta Dougl.), and Engelmann spruce (Picea engelmanni Parry) that was common on the site. The previous stand was a mixture of primarily lodgepole pine and grand fir; relative abundance of root disease in this stand was unknown.

Ten permanent plots 0.004 ha (0.01 acres) in size (6.4 m or 20.9 feet square) were established in October 1981 (fig. 2). These plots were placed around active groups of root disease mortality which was often located near infected stumps. Sufficient adjacent green trees were required to allow for monitoring of disease spread (fig. 3). Five plots (#1-5) were maintained at current stocking levels (unthinned) and the other plots (#6-10) were thinned with the remainder of the stand during November 1981. Thinning guidelines called for a 3.7 m by 3.7 m (12 feet by 12 feet) spacing of green trees - approximately 740 trees/ha (300 trees/acre).

Within unthinned plots, all trees greater than 0.6 m (2 feet) in height and all stumps from the previous stand were located by azimuth and distance from a common plot corner. Each tree and stump was identified with a permanent numbered metal tag and the following information collected: species, height, d.b.h. (if applicable) or stump diameter, and foliar condition. [2/] Yellow, red, or black trees and stumps from the previous stand were examined for signs or symptoms of root disease including resinosis, mycelial fans, and fungal sporophores.

2/ General foliage color throughout most of the crown: G = green (healthy); Y = yellow (chlorotic foliage); R = red (tree died within the past year); B = black (tree was dead for at least 2 years).



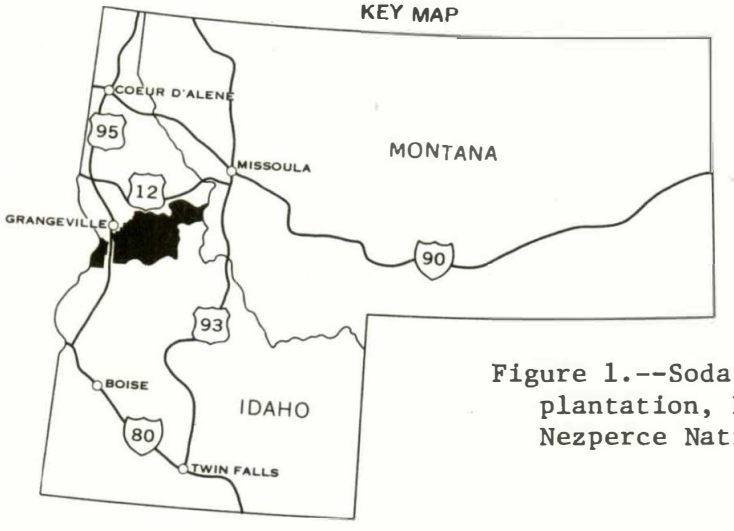
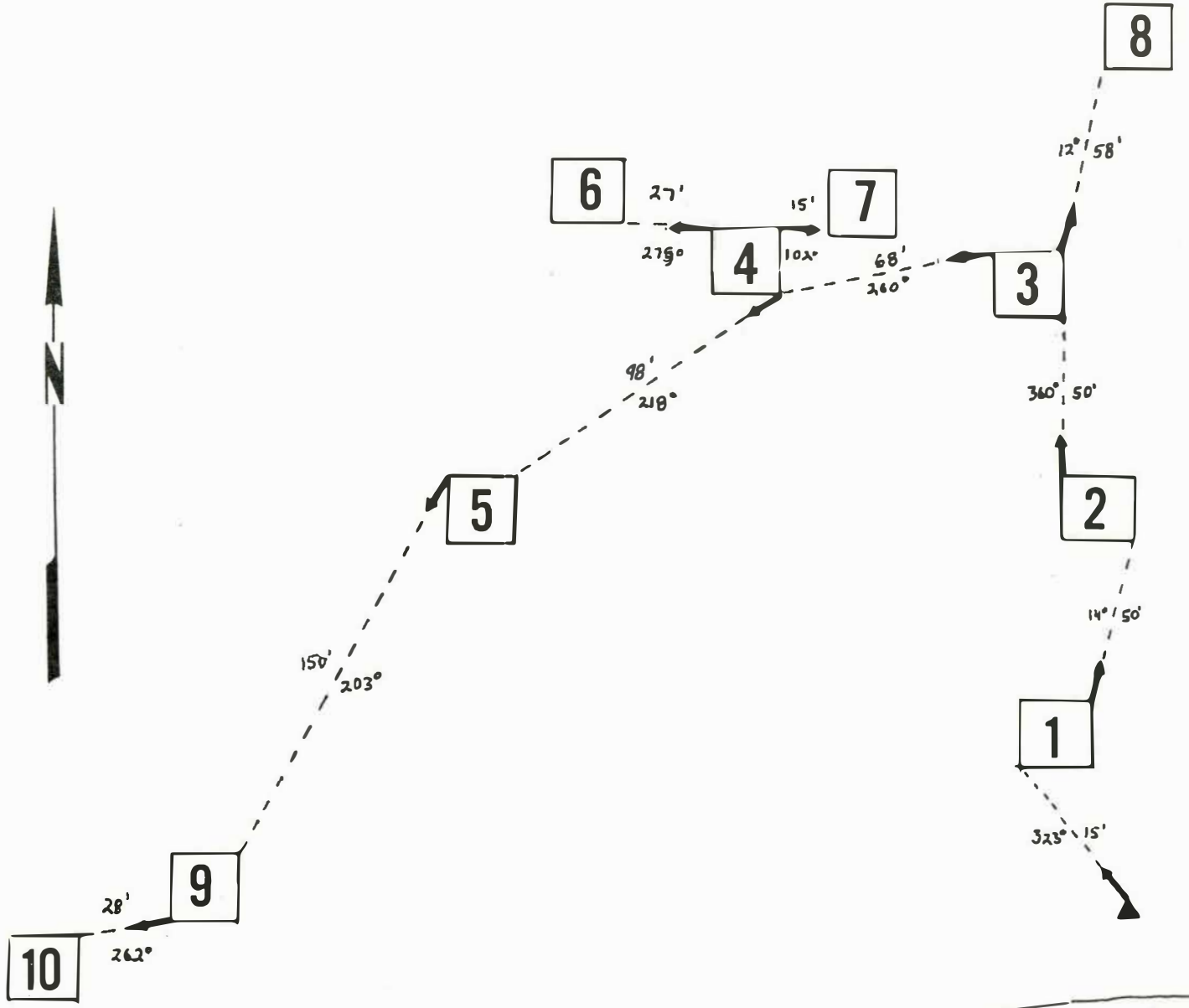


Figure 1.--Soda Creek (unit 2) (*) plantation, Red River Ranger District, Nezperce National Forest, Idaho.

Figure 2.--Location of root disease dynamics evaluation plots on the Soda Creek (Unit #2) plantation, Red River Ranger District, Nezperce National Forest.



Trees greater than 0.6 m (2 feet) in height and stumps were initially tallied within the plots to be thinned. Tree conditon by foliage color was also noted. Following thinning, residual trees and stumps from the previous stand were tagged, located, and measured as described for the unthinned plots.

Figure 3.--Plot to monitor root disease mortality on the Red River Ranger District, Nezperce National Forest. Note recently killed trees with red-brown foliage surrounded by sufficient green trees to monitor disease spread over time.

All plots will be monitored at least once every 2 years for root-disease spread as indicated by foliage color changes of infected trees.

RESULTS TO DATE

Approximately 12 percent of the grand fir and lodgepole pine were infected with root disease on the 10 plots (table 1). More than 80 percent of the tallied plot trees were grand fir (table 2). Lodgepole pine made up only 14 percent; other represented species included Engelmann spruce and subalpine fir (Abies lasiocarpa (Hook.) Nutt.). Much of the regeneration, especially grand fir, was grouped within plots. Plot stem maps are presented as figures 6 to 15 (appendix). These maps depict location and current condition of each plot tree. Maps will be updated periodically with transparent overlays to indicate changes in tree condition and include new plot trees (ingrowth).

Table 1.--Root disease incidence before thinning (1981) on plots established to monitor mortality dynamics in young regeneration on the Red River Ranger District, Nezperce National Forest. [1/]

Plot number	Grand fir			Lodgepole pine		
	Yellow [2/]	Red [3/]	Black [4/]	Yellow [2/]	Red [3/]	Black [4/]
1	0	1	1	0	0	0
2	0	3	4	0	0	0
3	1	1	1	0	0	0
4	1	6	8	0	0	3
5	0	0	4	1	3	3
Subtotal (Plots 1-5)	2 (0.9)	11 (4.8)	18 (7.8)	1 (1.7)	3 (5.2)	6 (10.3)
6	2	1	1	0	0	0
7	1	12	4	0	0	0
8	0	1	1	0	1	0
9	1	5	5	0	0	0
10	0	1	0	1	0	0
Subtotal (Plots 6-10)	4 (1.3)	20 (6.5)	11 (3.6)	1 (3.1)	1 (3.1)	0 (0)
All plots	6 (1.1)	31 (5.8)	29 (5.4)	2 (2.2)	4 (4.4)	6 (6.7)
Total infected [5/]	66 (12.2)			12 (13.3)		

1/ Figures in table are number of trees over 0.6 m (2 feet) tall. Percentages are in parentheses. No infected Engelmann spruce or subalpine fir were found on plots.

2/ Yellow trees were alive with chlorotic foliage; infections were verified from root crown examination.

3/ Red trees were recent mortality (within last year); infections were verified from root crown examination.

4/ Black trees died more than 1 year ago; foliage was often absent; infection was verified from root crown examination.

5/ Total number of trees infected on all 10 plots was 78 (12.3 percent).

Table 2.--Species composition of plots established to monitor root disease mortality in young regeneration on the Red River Ranger District, Nezperce National Forest. 1/

Tree species	Number of trees					
	Plots 1 - 5	Percent	Plots 5 - 10	Percent	All Plots	Percent
Grand fir	231	79.7	308	89.3	539	84.8
Lodgepole pine	58	20.0	32	9.3	90	14.2
Engelmann spruce	1	0.3	4	1.1	5	0.8
Subalpine fir	0	0	1	0.3	1	0.2

1/ Composition before plots 5 - 10 were thinned.

Thinning reduced stocking from about 17,000 trees/ha (6,900 trees/acre) to 1,000 trees/ha (400 trees/acre) (table 3). Unthinned plots are currently overstocked at about 14,300 trees/ha (5,800 trees/acre). An additional thinning may be required for the stand in the future.

Table 3.--Stocking characteristics of plots established to monitor root disease mortality in young rengeration on the Red River Ranger District, Nezperce National Forest.

	Plots 1-5	Plots 5-10		All plots
	Unthinned	Before thinning	After thinning	before thinning
Total trees 1/	290	345	20	635
Average no. trees/ plot 1/	58.0	69.0	4.0	63.5
Average density per ha (per A)	14,300 (5,800)	17,000 (6,900)	1,000 (400)	15,500 (6,350)

1/ Represents only tagged trees over 0.6 m (2 feet) in height.

The major root pathogen found on symptomatic trees was Armillaria mellea Vahl. ex Fr. Tree mortality commonly occurred around stumps. Infected trees had extensive basal resinosis (fig. 4) overlying large mycelial fans in the cambial region (fig. 5).

Figure 4.--Resinosis at the base of grand fir regeneration infected with Armillaria mellea

Figure 5.--Mycelia fans of Armillaria mellea at the base of infected grand fir regeneration

DISCUSSION

Root diseases are common in young stands regenerated on sites previously occupied by infected trees. Since inoculum may remain viable from one rotation to the next, accelerating losses of susceptible trees on infected sites might be expected.

Regeneration often becomes infected when young (5-10 years old) (Patton and Riker 1959; Weiss and Riffle 1971). Hazard of infection is especially greatest around stumps (Huntley et al. 1961; James and Gillman 1980). Pathogens like A. mellea, Phaeolus schweinitzii (Fr.) Pat., and Phellinus weirii (Murr.) Gilb. remain viable in stumps from one crop to another (Roth et al. 1980). Fomes annosus (Fr.) Cke., another common root pathogen, may infect freshly cut stumps via airborne spores, thus increasing general disease levels following timber harvest (Hodges 1969; Rishbeth 1950). Most root pathogens spread from infected stumps to surrounding regeneration through root contact, although A. mellea may spread short distances through soil via rhizomorphs (Singh 1981). Subsequent spread from tree to tree occurs primarily through root contact (Shaw et al. 1976). Groups of dead and dying trees are formed; lateral disease spread depends on stand density, species composition, and possibly other site factors. Understocked stands may result from multiple disease centers (Cook 1961; Filip 1979).

Previous investigations (Huntley et al. 1961; Johnson and Hawksworth 1977; Rykowski 1981) indicate that trees may become resistant to root disease with age. Although severe losses may occur during the early life of the stand, percentage of losses after 10 to 15 years are often reduced. Reasons for this apparent resistance are unknown; trees perhaps develop the ability to resist infection as they mature. Also, inoculum viability may decrease as the stand ages. Root disease may naturally select the most resistant genotypes by eliminating susceptible individuals early in the life of the stand. Other factors that might influence root disease development in young stands include (1) soil type, (2) habitat type, (3) species composition, (4) stand density, (5) number, size, and species of stumps on sites, (6) level of root disease in the previous crop, and (7) genetic makeup of the regeneration - especially susceptibility of planting stock as compared with natural regeneration (Buckland 1953). Unfortunately, little information on these effects is available. Disease intensity varies from site to site; we are unsure why.

Possible thinning effects on root disease dynamics range from accelerated losses to residual crop trees to improved likelihood of their survival (Roth et al. 1977; Shaw and Roth 1978). For example, a large number of stumps from thinning may stimulate saprophytic development of pathogens resulting in sufficient inoculum buildup to successfully infect crop trees (Filip 1977). On the other hand, thinning may enhance vigor of selected crop trees sufficiently to resist pathogens (Baranyay and Stevenson 1964; Johhnson and Thompson 1975).

Plots were established on the Red River Ranger District to help answer these questions. Investigations should be conducted within several different stands encompassing a range of habitat types and species composition in order to provide the basis for accurate management recommendations regarding thinning in young root-diseased stands.

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APPENDIX

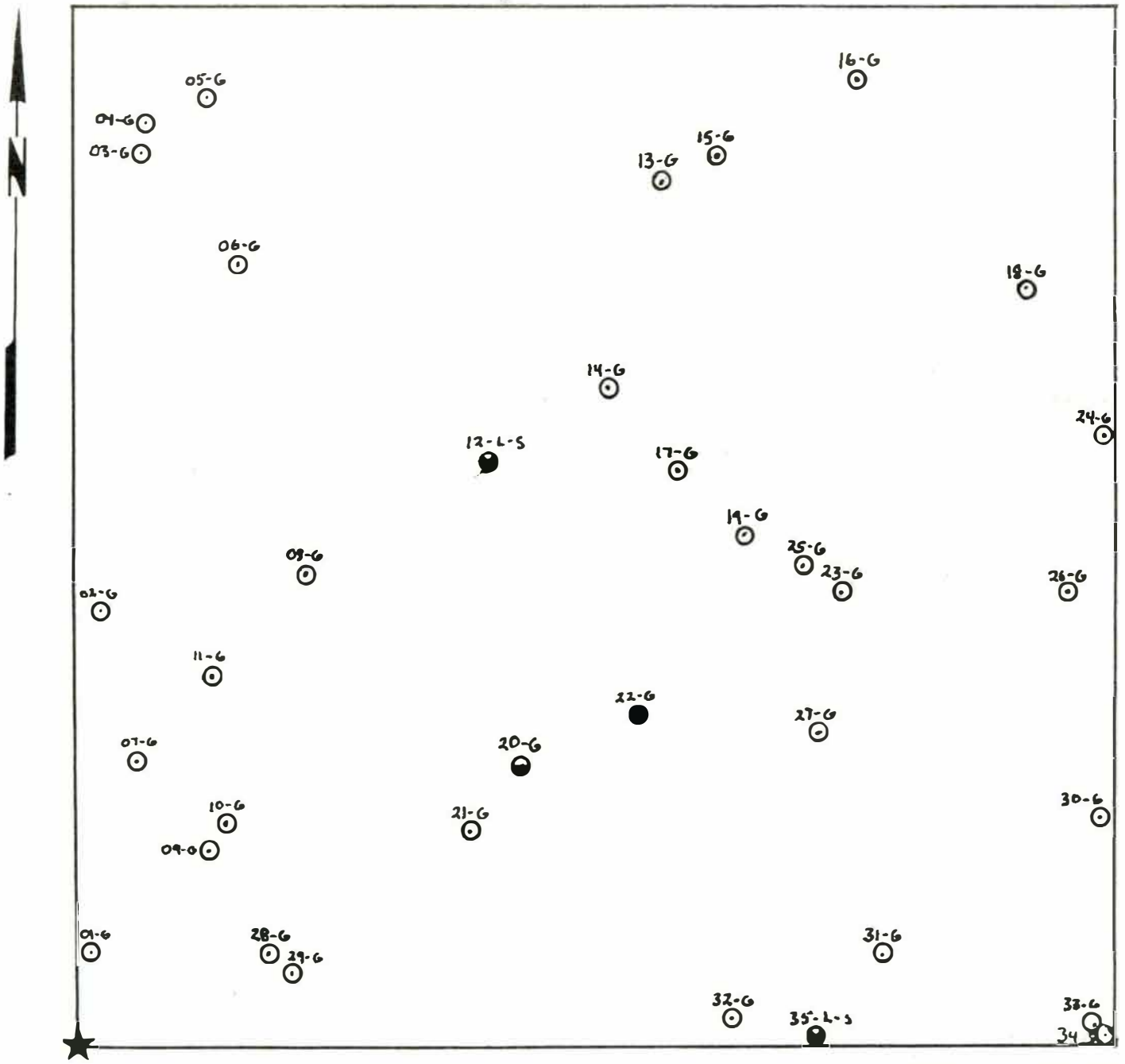

Figure 6.--Stem map of regeneration plot 1. Red River Ranger District, Nezperce National Forest.

Figure 7.--Stem map of regeneration plot 2. Red River Ranger District, Nezperce National Forest.

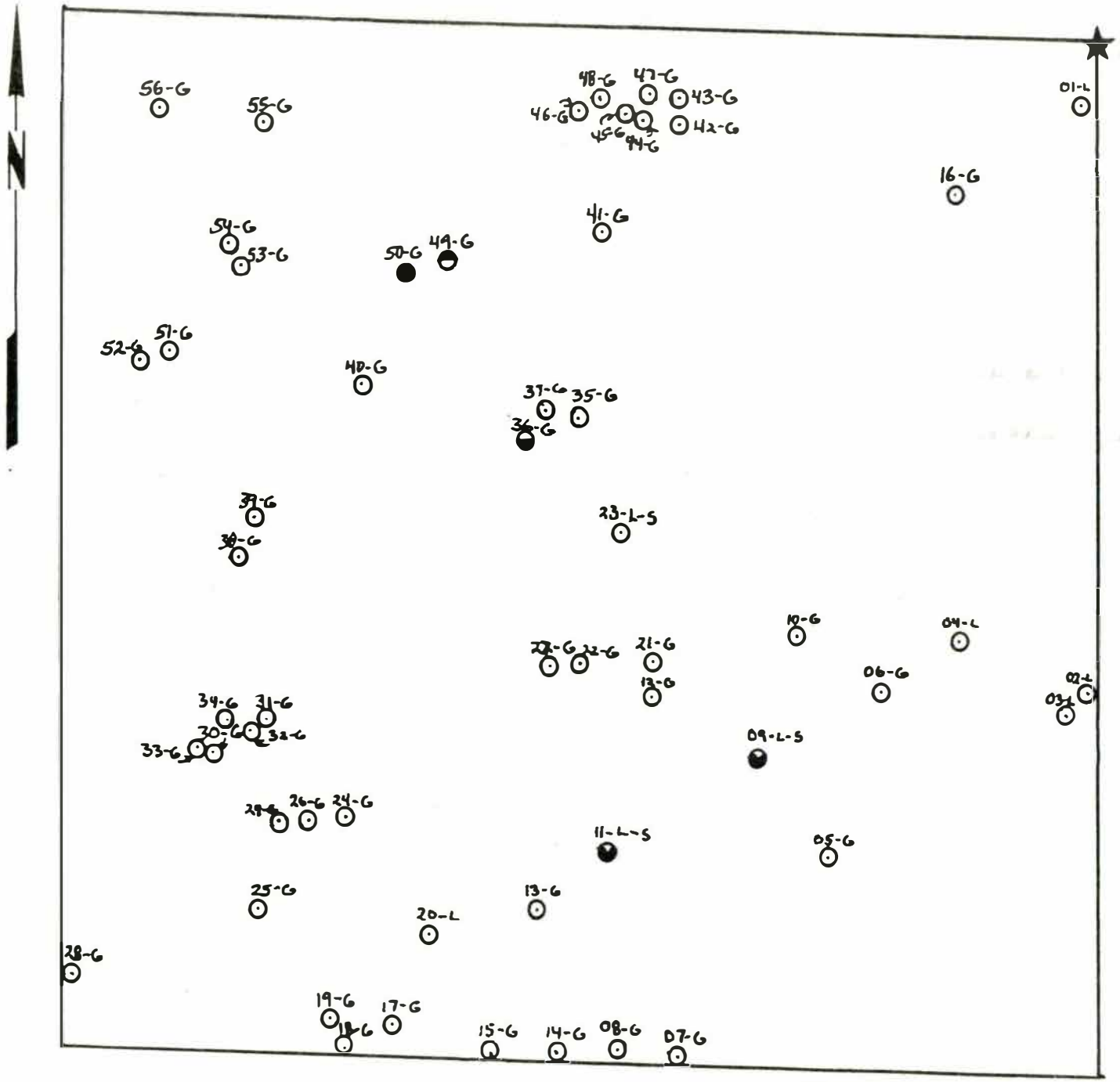

Figure 8.--Stem map of regeneration plot 3. Red River Ranger District, Nezperce National Forest.

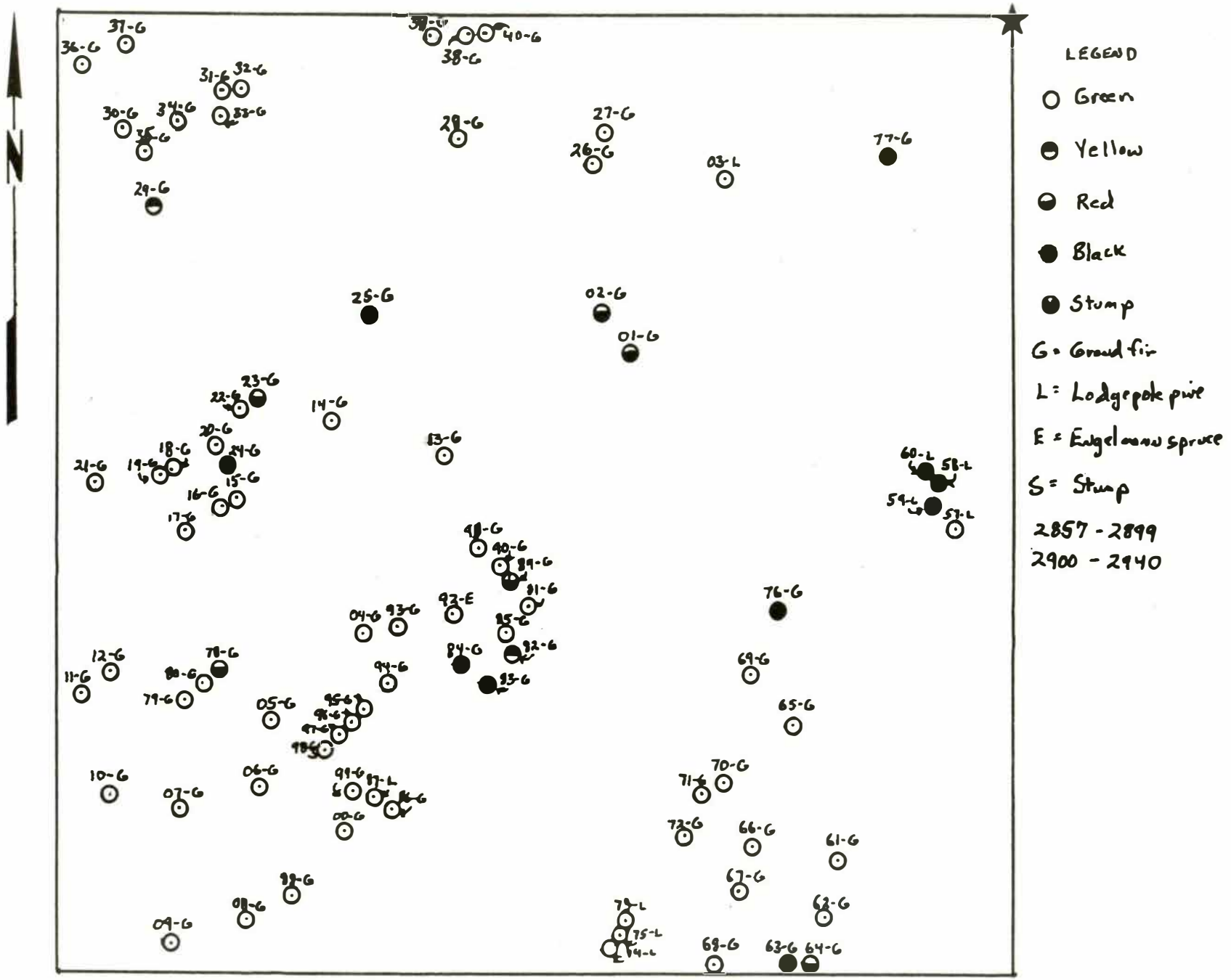

Figure 9.--Stem map of regeneration plot 4. Red River Ranger District, Nezperce National Forest.

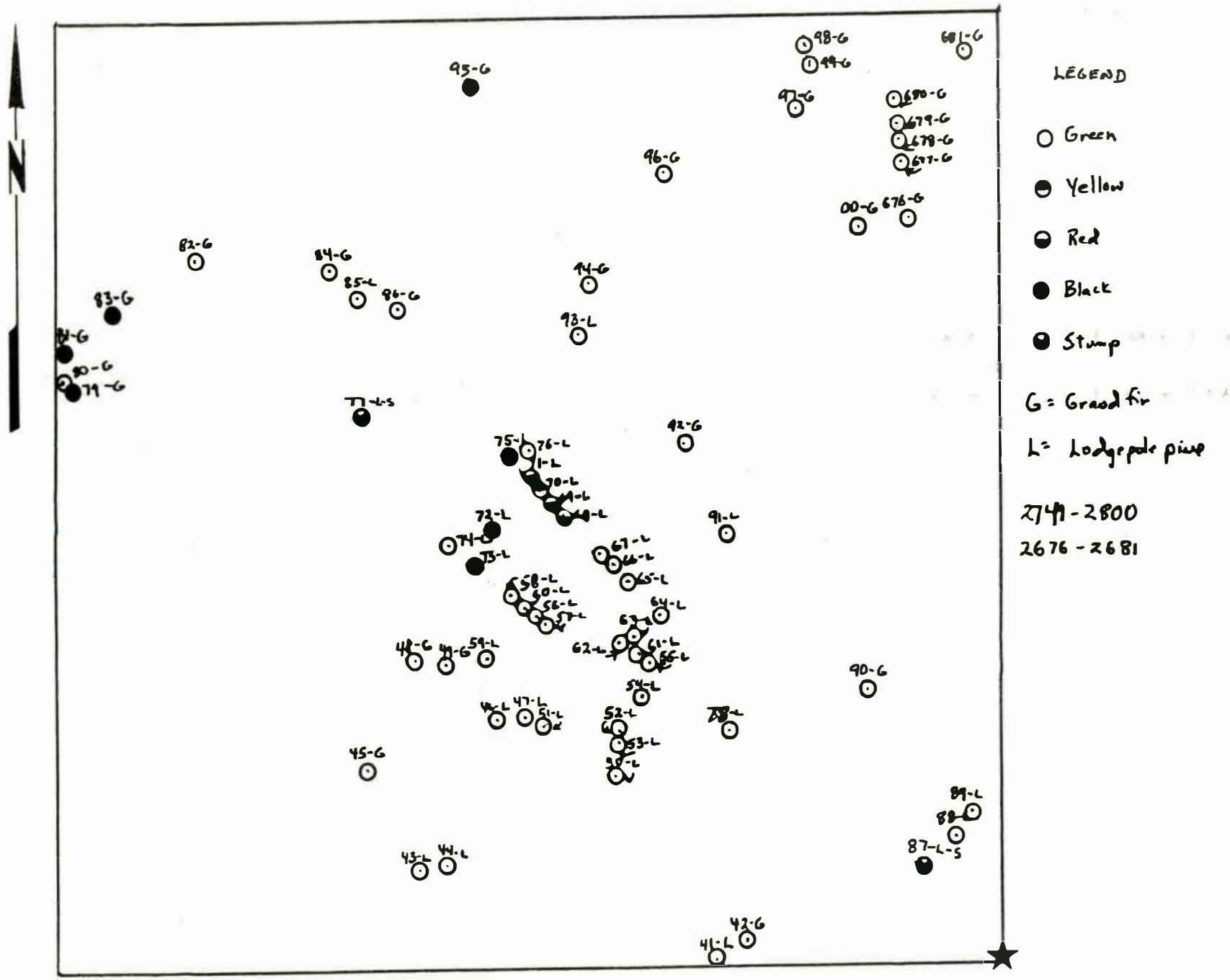

Figure 10.--Stem map of regeneration plot 5. Red River Ranger District, Nezperce National Forest.

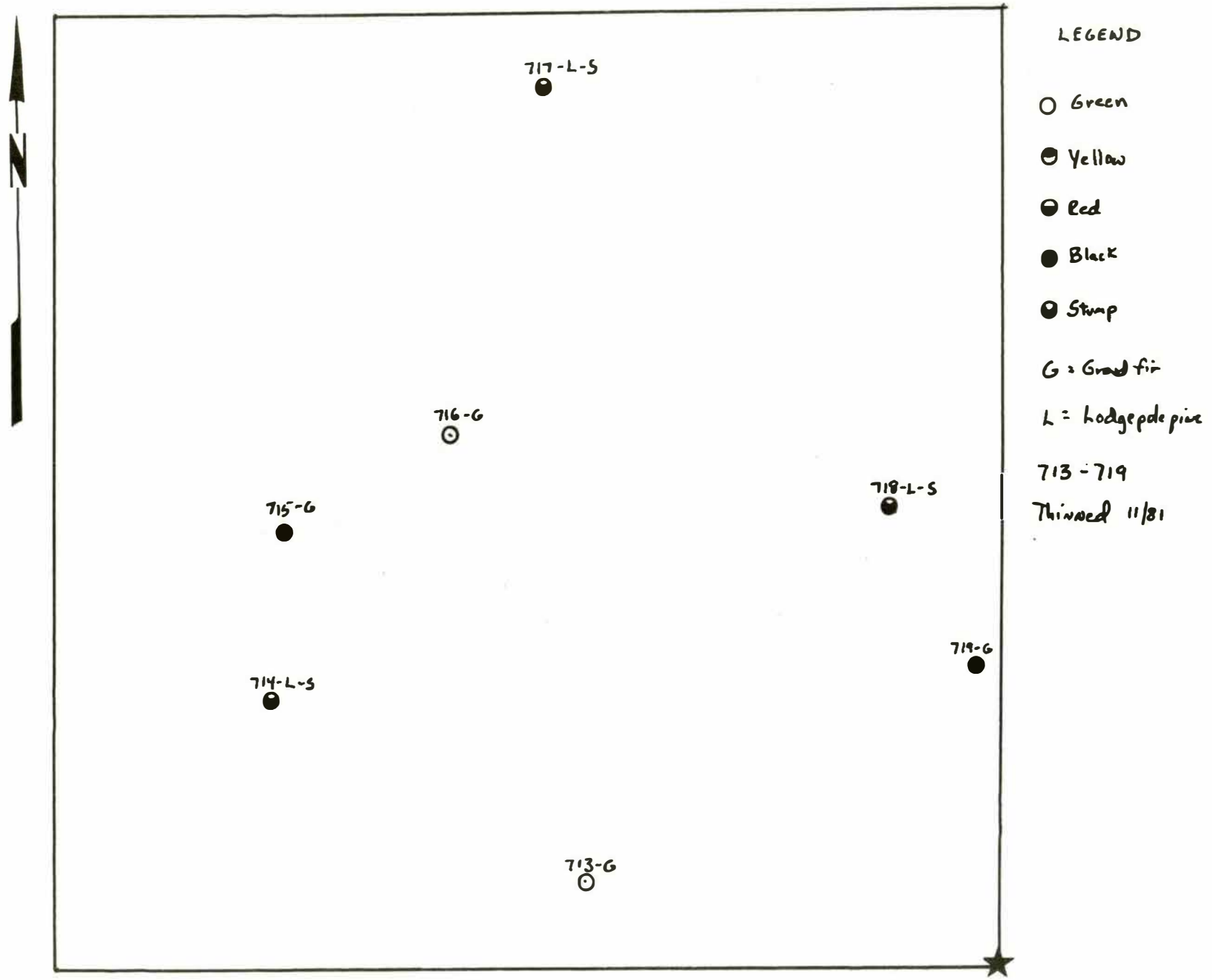

Figure 11.--Stem map of regeneration plot 6. Red River Ranger District, Nezperce National Forest.

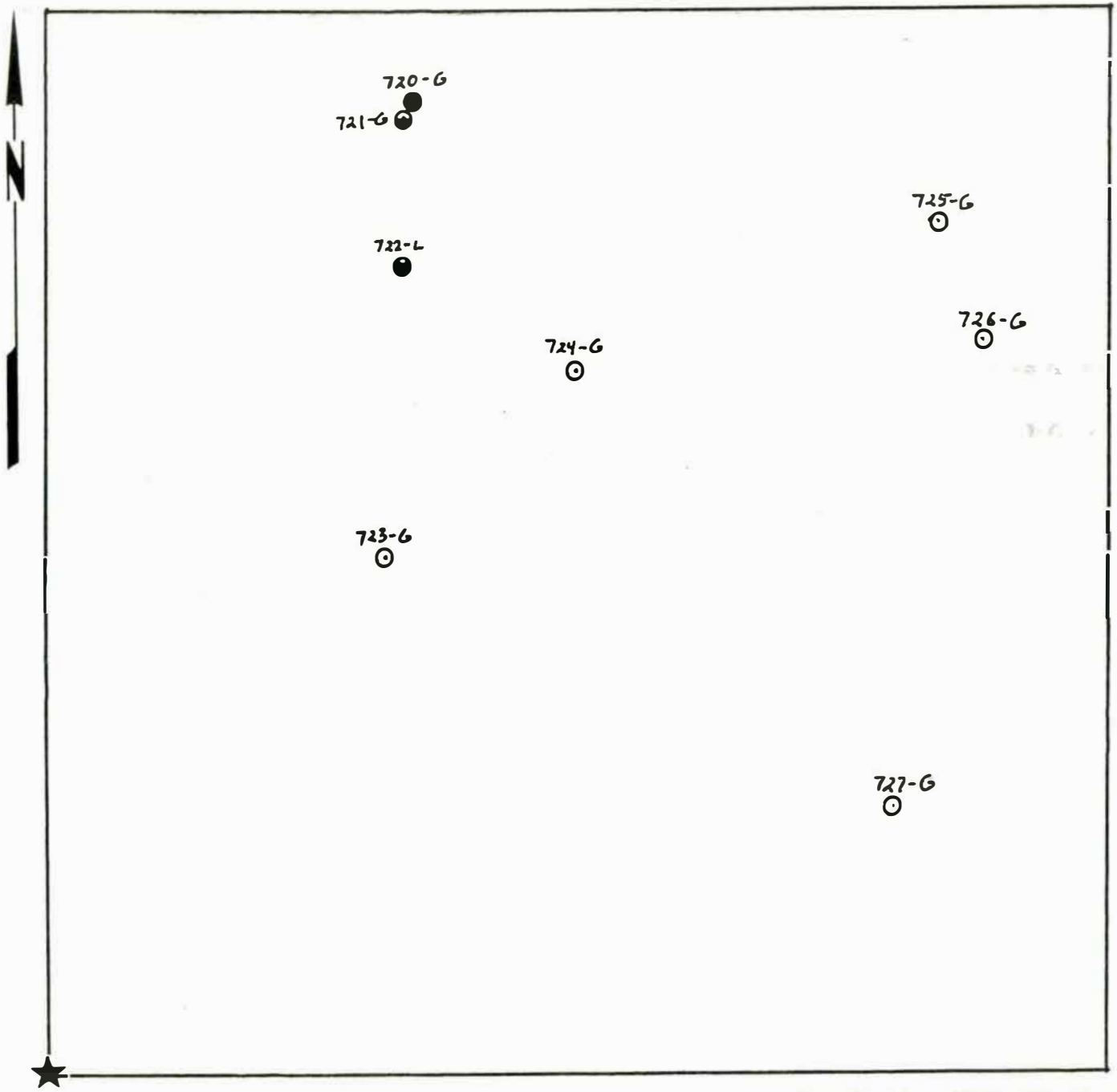

Figure 12.--Stem map of regeneration plot 7. Red River Ranger District, Nezperce National Forest.

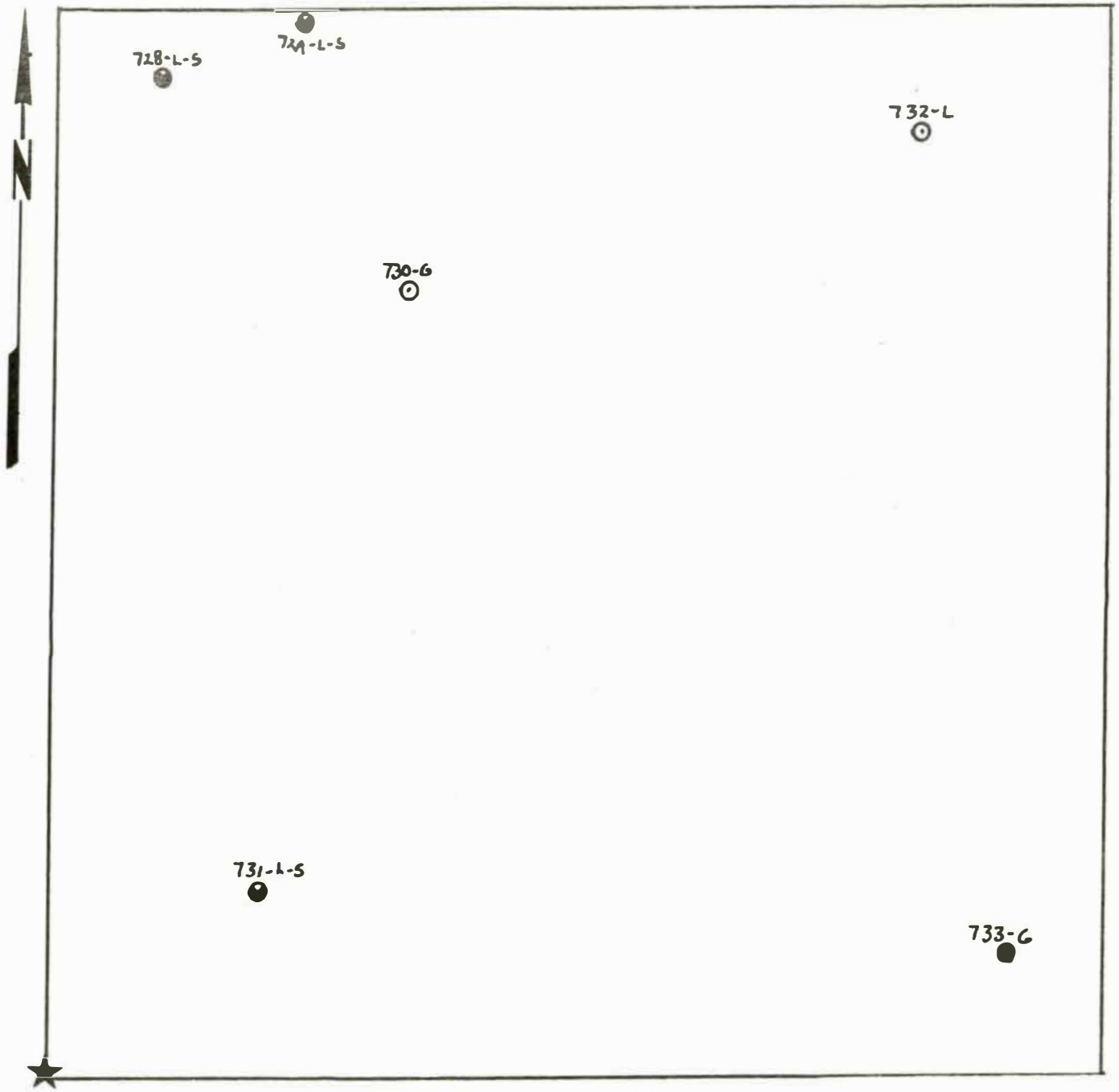

Figure 13.--Stem map of regeneration plot 8. Red River Ranger District, Nezperce National Forest.

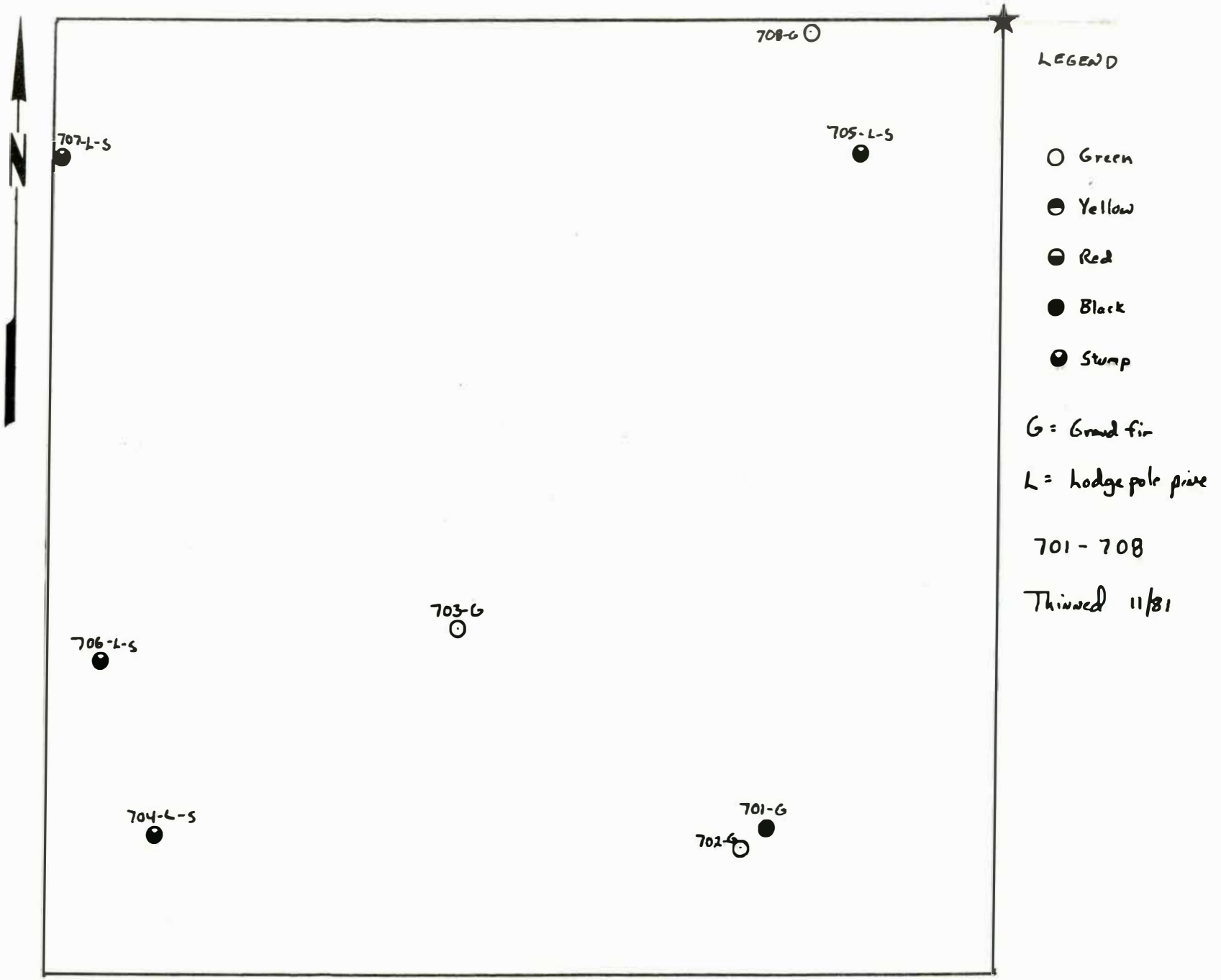

Figure 14.--Stem map of regeneration plot 9. Red River Ranger District, Nezperce National Forest.

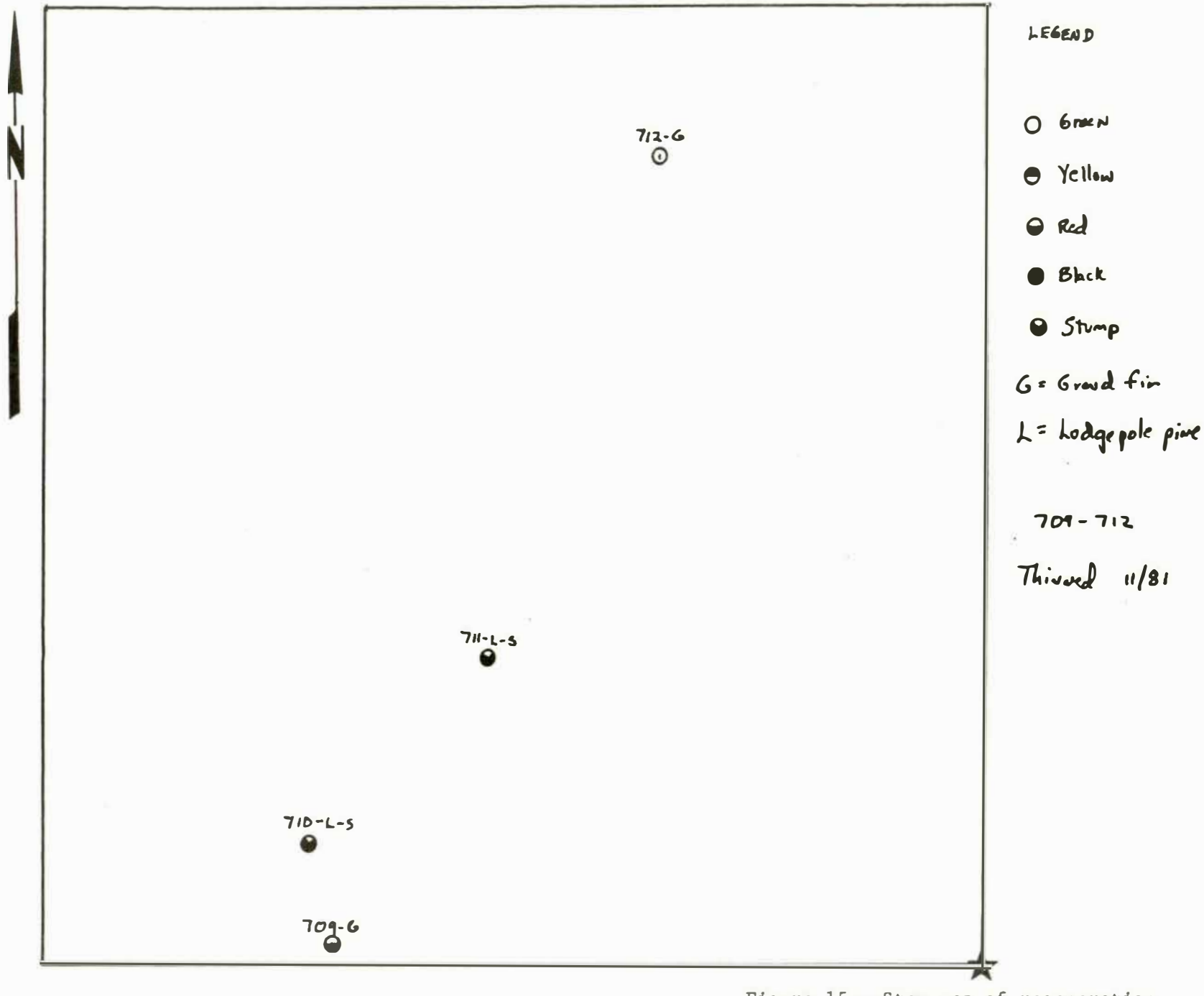

Figure 15.--Stem map of regeneration plot 10. Red River Ranger District, Nezperce National Forest.